LP's Report on the Activity A1.1. "Framework for smart 3D pollution monitoring" within Reporting Period 1

Summary

Within the A1.1. The LP has found that the technological solution to be used – the solar glider must have a load capacity that allows carrying two batteries, solar panels, and as many sensors as possible changes depending on the task of the glider; also there is enough space on the hull to be able to place more sensors. The glider must be resistant to all weather conditions, during which surveillance should be carried out continuously and uninterrupted; Engines together with the panels that fill it and the ability of the sailboat to sail in certain conditions should allow the sailboat to be in the air for at least 24 hours to several days. Carrying out this activity will define the exact time autonomy. As a part of this project, we concluded that up to one hour could be enough for initial tests and monitoring phases (for more complex routes, agencies, and governmental bodies should allow us the flight paths). Aspects of environmental protection were also emphasized since glider is powered by electricity, partially obtained from built-in solar cells.

Task Description:

The following sub tasks have been conducted:

1. Concept Formulation and Theoretical Validation (both concept and technology) of the autonomous system. This involved a comprehensive examination of the solar glider and drone technology, ensuring they align with the project objectives. RIT conducted tests to validate the technology's feasibility, focusing on data acquisition and types of sensors that could be implemented together with the communication channels (more on that in the description of the work on Activity A 1.1 in the Work Plan Progress section).

2. Collaborative Concept Definition about the objectives, scope, and requirements of the autonomous system. We defined the minimum energy capacities that are needed for glider power, payloads for glider and drone, and a holistic approach to system development, taking into account diverse perspectives and expertise. Through joint discussions and workshops, the partners contributed to shaping a well-defined and comprehensive concept for the system. RIT in particular analyzed options and alternatives for the solar glider.

3. Theoretical Validation was done by utilizing simulations and analyses, in order to assess the feasibility and effectiveness of the proposed system. This involved stress-testing the concept under various

scenarios and ensuring it meets the project's air quality monitoring objectives. Theoretical validation provided insights into potential challenges and refinements needed for the autonomous system, such as the need for pilot licenses for operating the glider and the drone. The solar glider will use engines to take off, move, and land, but it will also have the ability to glide, which will significantly prolong its stay in the air. When the engines are off, the batteries are consumed exclusively by the sensors attached to the glider. Since the glider will be much larger than fixed-wing drones, it will be able to carry more batteries, which also increases its flight time. Initial research estimated that the glider will have an autonomy of up to 5 days in favourable conditions.

4. Technology Component Testing of the autonomous system, specifically the solar glider and drone. The focus is on verifying the functionality, performance, and compatibility of these components with the monitoring objectives. This phase also involved assessing the ability of the solar glider and drone to operate autonomously and collect the required data accurately. This provided valuable input on the operational aspects of the solar glider and drone, ensuring that these components align with the project's overarching goals. The assessment covered both functionality and performance, allowing for collaborative problem-solving and optimization.

The objective was to combine three variables that bring a significant improvement over all existing solutions on the market. We designed a glider capable of being modular by carrying and using different configurations, commercially available cameras, sensors, batteries, and other auxiliary technologies, with minimal disruption of the aerodynamic characteristics of the aircraft.
From the connectivity perspective, we added a module that accepts SIM cards which will allow us to have an internet connection while in the air in the areas that have signal coverage by the telecom operators. We defined the 5V wireless GSM GPRS module quad band 850/900/1800/1900MHz module as being capable of different modes of communication, with an additional Bluetooth module for near-field communication. The communication interface between the microchip and the rest of the system is defined as RS232 TTL for fast communication that allows multiple devices to be connected at the same time (to the same host). For the microchip, we opt for an Arduino-based solution with an additional SD card module as a potential data logger for the areas not covered by the GSM signal. The main reason for this is to obtain a low-cost solution. Additionally, we added to our communication framework GPS Flight Control Module 3V-5V for flight control with a data backup battery as a secondary circuit to ensure flight even with disruptions of the main power supply. We also added a Real Time Clock RTC Module for measuring precise time with an additional data backup battery as a secondary circuit to ensure flight even with disruptions of the main power supply.
For the air quality measurements, we defined a variety of different sensors for different aspects of air monitoring. It is important to emphasize that due to the glider size and payload characteristics, together with the energy-consumption reasons, at one moment it could be mounted only a subset of these sensors:

● PM1.0, PM2.5, PM10: Inhalable particulate matter is not a single pollutant but a mixture of many chemicals. 10, 2.5, and 10 represent size in micrometers. PM2.5 is most dangerous as it can infiltrate the lung tissue and cause inflammation.
● Volatile Organic Compounds (VOCs): Typically, are industrial solvents, such as trichloroethylene; fuel oxygenates, such as methyl tert-butyl ether (MTBE); or by-products produced by chlorination in water treatment, such as chloroform. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry-cleaning agents. VOCs are common ground-water contaminants.
● CO: It results from the incomplete combustion of carbon-containing fuels such as natural gas, gasoline, or wood and is emitted by a wide variety of combustion sources, including motor vehicles, power plants, wildfires, and incinerators.
● Ammonia: A byproduct of the industry but mostly agriculture. Long-term health concerns related to ammonia exposure include severe cardiovascular and respiratory effects. decreased lung function.
● Methane, Propane, Isobutane: Powerful greenhouse gases
● Nitric Oxide (NO_2 and NO_3): Combustion of hydrocarbons
● Dust
● CO_2
● Temperature, humidity and pressure
● Infrared for open flame to detect possible (wild)fire
● UV
The solar glider, due to its GPS and RTC sensors can capture the accurate position of data sampling and if any of the captured data from the sensors is higher than any threshold, that GPS location(s) is/are shared with the programmable drone with its own set of sensors for air quality measurements (that could be again adaptable to the needs of that specific air-monitoring): The role of the drone is to cover the area close to the indicated location more accurately because drone can fly steadily contrary to the drone which flies at some 60km/h.